REDUCTION IN LEATHER VALUE AND YIELDS OF MEAT AND WOOL FROM SHEEP INFESTED WITH KEDS*

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ABSTRACT

It was recently established that cockle, a defect of sheepskin leathers which results in serious economic losses, is caused by seasonal infestation of the living animal with sheep ticks or keds (*Melophagus ovinus*). To provide enough incentive for implementing an eradication program against this parasite, evaluation of its total economic damage was undertaken by means of a controlled test on 110 insect-free lambs, half of which were infested.

Reductions in market values of three types of leather were determined, along with similar differences for pickled skins and for graded carcasses. The infested sheep also yielded significantly lower results for carcass weights and for wool growth. Estimated potential benefits indicate a very substantial profit incentive for eliminating keds.

INTRODUCTION

The sheepskin defect known as cockle is still a serious problem to the leather and woolpulling industries. In 1913 Seymour-Jones (1) published an accurate account of the condition but was led to an inaccurate conclusion as to its cause. During the following 55 years, no better explanation was offered and further research was essentially neglected. In February, 1969, a U.S.D.A. report (2) outlined the work of Everett and Roberts, revealing for the first time that the common sheep ked (*Melophagus ovinus*) was responsible for cockle. In April of the same year Laidet (3), in France, independently reported the same conclusion. A complete account of the former work appeared later that year (4).

Identification of the cause should be unusually helpful to the solution of this problem because there is already a voluminous literature on the biology of the

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ked and on effective measures for its control. This particular blood-sucking parasite has been known for centuries, having first been accurately described by Moufet in 1634, according to Bequaert (5). It is uniquely inefficient in its reproductive capacity, each female producing a single larva at intervals of seven to eight days for a total of only 12 to 15 during her lifetime (6, 7). For this reason it should be a relatively simple matter to eradicate the parasite by a compulsory treatment program. Agricultural bulletins (8, 9) describe the use of a number of effective insecticides for application by dipping, spraying, or dusting. Owing to its low toxicity and cost, a rotenone dip is generally recommended as the most practical method for general use, especially since a single treatment will suffice to eliminate the parasite.

In order to provide enough incentive for implementing a suitable control program, it has become apparent that an economic appraisal of the total damage caused by keds is needed. In addition to the losses suffered by tanners and woolpullers due to the cockle defect, it is important to estimate the reduction in weight gains from the grower's standpoint, the lower carcass weight and inferior quality from the packer's viewpoint, and the lower yields and quality of wool. Previous reports in the literature (10–13) claimed that keds do not adversely affect either weight gains or wool growth. However, several unsupported statements (8, 9, 14–16), as well as logical deduction, indicate that the irritation and blood loss caused by the ked's feeding activity interfere with the infested sheep's nutrition and reduce its rate of weight gain and wool growth, and may lead to anemia and lowered disease resistance.

In 1917 (15) a survey of sheep growers in Utah indicated annual losses amounting to 25 cents per head for lambs and 20 cents for ewes. It was pointed out that previous compulsory dipping for scabies had also controlled keds, but relaxation of this program resulted in a rapid rise in ked severity. A small-scale study in Ohio cited by Bequaert (5) reported lower weight gains by infested lambs, but the difference was small. Nelson and Slen (17), in Canada, described a series of experiments that better document the losses that can be expected. In one test, ked-free lambs gained almost eight pounds more than infested lambs on alfalfa hay; in another test using a high-energy ration, there was a difference of more than three pounds. In a further test with yearling ewes, the uninfested sheep produced about 11 percent more wool than the infested ones.

This report describes the results of a controlled test involving 110 insect-free lambs, half of which were experimentally infested with keds in the fall of 1968. It was designed to measure the effect of ked infestation on the value of the three principal sheep commodities: meat, wool, and skins. Losses resulting from lower weight gains, lower carcass weights and grades, lower wool quality (cleanliness) and wool growth (yield), lower value of pickled skins, and lower value of three different types of leather provide adequate supporting evidence to justify the cost of undertaking an eradication program.

EXPERIMENTAL METHODS

Test Design

A flock of 110 lambs, born and raised under conditions assuring freedom from all external parasites, was paired according to sex and breed type at Albuquerque, New Mexico. The principle of paired selection was applied, similarly to a previous test designed to show the cause of cockle (4). The flock was treated as two groups, infested *vs.* uninfested, individual identities being maintained by means of ear tags. The animals involved were small, lightweight, crossbred lambs, chiefly of Rambouillet breeding, approximately six months of age at the start of the experiment. All were selected from the same flock of some 200 ewes. Throughout the duration of the test they were fed alfalfa hay only, on the assumption that a maintenance diet would assist in favoring adequate ked propagation (6, 9).

Ked Infestation

A plentiful supply of keds was provided by heavily infested donor sheep that had been pastured during the summer at a higher elevation. Manual transfer to the shoulders of experimental lambs, for a total of 225 per head, was carried out during several separate episodes, until check counts finally indicated that the infestations were successful. Monthly counts thereafter, from December through April, were made by placing the animal on its side, carefully and systematically parting the wool at close intervals, and counting all the adult keds. This figure was doubled to represent the total count, a procedure previously shown to be reliable (18).

Pelt Processing

After slaughter in May at a local abattoir, the unshorn pelts were removed and thoroughly salted on the flesh side; identification numbers were stamped into each skin. Following storage for several days to permit salt penetration, with precautions to avoid overheating, the skins were packed into wooden crates and shipped to a commercial woolpuller in Philadelphia. Unfortunately, many of the skins became excessively dry and rigid under prevailing climatic conditions, leading to undesirable damage in the form of cracked grain and mild heat spoilage. Much of this damage was overlooked in subsequent grading of the skins, since it could not be attributed to keds. The experimental skins were processed according to the usual plant procedure, and were finally graded by the pickled skin sorter as to presence of cockle. Current market values were assigned to each skin. Two of the uninfested skins were lost in the plant.

Leather Processing

The graded, pickled skins were shipped to a commercial sheepskin tannery in two lots for processing into three common lines of leather. Two dozen skins

from each group were made into brown garment suede; another two dozen from each were made into black slipper upper leather. These represented the two most important lines produced by this tannery, where cockle was known to downgrade the quality to a serious extent. The remaining skins, seven from each lot, were made into shoe lining leather, where cockle skins can often be utilized without such serious losses. Finished leathers were carefully graded for defects except grain crack, and market values were assigned on the assumption that the skin areas equaled 100 square feet per dozen, which is average for domestic skins. Owing to the small size of the lambs, the skins were actually rather small, but under commercial conditions they would meet the above requirement.

Carcass Evaluation

After chilling for two days, the carcasses were weighed, and conventional grades were assigned to each by a meat grader of the Consumer and Marketing Service, U. S. Department of Agriculture. Dressing percent was calculated by expressing the carcass weight as percent of live weight. Current market values were assigned on the assumption that the carcasses met usual marketing specifications, although they were actually rather small and light in weight. One infested sheep died of mechanical injuries en route to the abattoir, just prior to slaughter; the pelt was removed and the carcass weighed at the abattoir, but meat inspection regulation precluded acceptance of the carcass for grading and pricing.

Wool Analysis

The pulled wool obtained from the pelts at the woolpullery was accumulated into graded lots as usual. Each lot was sampled by the standard procedure and the samples were submitted to a commercial testing service** for analysis of the "clean wool fiber present" to determine the amount of foreign matter present. It would be expected that a ked-infested fleece would carry more contamination and thus result in a lower return to the woolpuller (9, 19).

Wool Growth

Comparative growth rates of wool were estimated for the two groups by isolating, with animal clippers, a standard area three cm. square on the shoulder of each animal, somewhat like the method of Slen (17, 20). At the start of the test all areas were clipped closely. At the end of the test the same areas were again clipped close to the skin, and the wool staples thus produced were analyzed by a standard procedure to determine the average fiber length and the clean dry weight. These data serve as a measure of potential wool yields but, because of the size of samples, they are not sufficient to calculate a meaningful difference in market value.

**United States Testing Company, Inc., Philadelphia, Pa.

RESULTS AND DISCUSSION

Live and Carcass Weights

Table I summarizes the differences between the control and infested sheep with respect to weight gains and carcass weights. It is evident that both groups were quite comparable in their initial and final live weights. Repeated weighing during the test failed to show any significant trends, and there was an average advantage of only one pound in weight gain in favor of the controls. Dressed carcass weights, however, showed a small (two pounds) but significant ($P = .01$) difference favoring the controls when the data were analyzed as 55 pairs. Likewise the dressing percentage was two percent better for the controls.

TABLE I

EFFECT OF KEDS ON LIVE AND DRESSED CARCASS WEIGHT

Characteristic	Average Values Found		
	Uninfested	Infested	Difference
No. of Sheep	55	55	
Live Weights (lbs.)			
Initial (Sept.)	41	40	1
Final (Apr.)	72	70	2
Gain	31	30	1
Carcass Data			
Dressing Percentage	39	37	2
Dressed Wt. (lbs.)	28.3	25.9	2.4*
Standard Error	0.70	0.68	
Range	18–42	15–38	

*Statistically significant ($P = .01$)

During our first sheep test (4), unreported data were also collected on the weight gains of 65 pairs of infested *vs.* uninfested sheep of varying ages. These results are reported here since they are more pertinent to the present study. Variable differences were found at different time intervals, but there was a consistent trend in favor of the controls, amounting to an average advantage of five pounds for the uninfested sheep. This serves as reinforcement for the one-pound advantage reported in the current study. Data were also collected on the carcass weights of 41 pairs of infested *vs.* uninfested sheep from this first test. The average difference amounted to two pounds in favor of the uninfested controls, which is consistent with the same figure derived from the present study.

Carcass Values

Results of carcass grading and estimated market values for the two groups are shown in Table II. Total market value represents the product of weight

and price within each grade. This is also expressed as an average value per carcass to indicate the value of the weight differences found between the two groups. Comparison of grading results shows 21 choice for the controls but only 12 for the infested group. The average value of uninfested carcasses was $18.40, while the average for infested carcasses was $16.76, showing a difference of $1.64 per carcass in favor of controls.

TABLE II

EFFECT OF KEDS ON CARCASS GRADE AND VALUE

Grade	Number	Total Weight (lbs.)	Price Per Lb.* (dollars)	Market Values	
				Total (dollars)	Carcass (dollars)
		UNINFESTED (55)			
Choice	21	667.5	0.67	447.23	21.30
Good	24	646.0	0.65	419.90	17.50
Utility	10	241.0	0.60	144.60	14.46
	55	1,554.5		1,011.73	
				Average	18.40
		INFESTED (54)†			
Choice	12	371.5	0.67	248.91	20.74
Good	33	840.8	0.65	546.52	16.56
Utility	9	183.0	0.60	109.80	12.20
	54	1,395.3		905.23	
				Average	16.76
				Difference	1.64

*Source: National Provisioner Daily Market and News Service, May 15, 1969 (adjustment made at Albuquerque, New Mexico, for freight and demand).

†One subject dead on arrival at abattoir; carcass not graded.

Wool Growth

The measurements on standard wool staples and their variability are shown in Table III. Average difference in length amounted to 2.5 mm. or about eight percent, while the difference in clean, dry weight was 193 mg. or about 20 percent, both in favor of controls. Statistical evaluation by one way analysis of variance, using a completely randomized design, showed the differences to be highly significant ($P = .01$). Admittedly these data are only suggestive of the difference in yield that might result from ked-free sheep under commercial circumstances. Since the experimental sheep were not paired on the basis of fleece characteristics, actual significance of the results is uncertain. In terms of an average eight-pound fleece, a 20 percent loss would amount to 1.6 pounds at an estimated 40 cents per pound, or 64 cents per fleece.

TABLE III

EFFECT OF KEDS ON WOOL YIELD AND QUALITY

Characteristic	Average Values Found		
	Uninfested	Infested	Difference
Standard Wool Staples			
No. of Sheep	54*	55	
Length (mm.)	29.3	26.8	2.5†
Std. Error	1.87	1.86	
Range	20.0–40.3	17.0–34.6	
Clean Dry Wt. (mg.)	967	774	193†
Std. Error	31.6	31.3	
Range	692–1682	397–1596	
Pulled Wool Grade	Percent Clean Fiber Present		
No. of Sheep	55	55	
6400	82.2	72.0	+10.2
6402	72.7	74.7	− 2.0
6409	76.6	64.4	+12.2
		Average	+ 6.8

*Sample not obtained from one subject.
†Statistically significant (P = .01).

Wool Cleanliness

Analyses of graded lots of the pulled wool are also shown in Table III. A variable difference is evident, but on the average there is an advantage of about seven percent favoring the uninfested controls. Pulled wool is sold on the basis of its clean fiber content. Since the grades involved sold for about one dollar per pound, it can be estimated that ked-free wool would profit the woolpuller about $7.00 per 100 pounds (clean basis).

Pickled Skin Values

Table IV describes the grading and pricing of the pickled skins by the woolpuller. Numbers of skins are also expressed in dozens, the usual unit of the industry. As explained under experimental methods, grain crack in many of the skins was ignored for the purpose of this test, since it was caused by excessive drying out during curing and was not due to keds. Likewise the heat grade might have beeen ignored but has been included in the calculations. It can be seen that there were no top quality (suede) skins in the infested group; all of them showed definite cockle, and a few were also heat-damaged or torn. One skin in the uninfested group was graded as showing cockle, but the suede leather made from this skin showed no signs of typical cockle. Estimated market values

TABLE IV

EFFECT OF KEDS ON PICKLED SKIN VALUE

Grade	No. (doz.)	Price Per Doz. (dollars)	Market Values		
			Total (dollars)	Dozen (dollars)	Skin (dollars)
		UNINFESTED (53)*			
Suede	46 (3.833)	19.75	75.70		
Cockle	1 (0.083)	13.25	1.10		
Heat	4 (0.333)	8.50	2.83		
#1	2 (0.167)	3.00	.50		
	53 (4.417)		80.13	18.14	1.51
		INFESTED (55)			
Cockle	51 (4.250)	13.25	56.31		
Heat	3 (0.250)	8.50	2.13		
#1	1 (0.083)	3.00	.25		
	55 (4.583)		58.69	12.81	1.07
		Difference		5.33	0.44

*Two skins lost in processing plant.

show a difference of $5.33 per dozen, or 44 cents per skin, in favor of the uninfested controls, which represents a significant loss to the woolpuller.

Leather Values

Grading and pricing of the three types of leather made from the experimental skins are described in Table V. Again the numbers are expressed in dozens, as the unit of the industry, and on an individual basis for computing the total effect of keds. Considering first the garment suede, the grades shown actually involve cockle and a number of other defects as well, but cockle severity is indicated to show how strongly it affects pricing. As mentioned previously, the area of each skin and the presence of grain crack were disregarded for the purpose of this test. The data obtained show that there was a difference in value of $20.17 per dozen favoring the uninfested controls, or $1.68 per skin.

Evaluation of the slipper upper leather was done in a similar manner, but the downgrading effect of cockle was less pronounced. There was a difference in value of $3.93 per dozen favoring the controls, or 33 cents per skin. The effect on the value of lining leather was almost negligible, amounting to only 22 cents per dozen or about two cents per skin. However, only seven pairs of skins were made into this type of leather, making it less comparable with the other two types. The main point to be emphasized is that ked-infested skins are responsible for very substantial losses to the manufacturer of suede leathers.

TABLE V

EFFECT OF KEDS ON MARKET VALUE OF FINISHED LEATHERS

Uninfested Skins						Infested Skins					
			Market Values						Market Values		
Grade	No. (doz.)	Price Per Doz. (dollars)	Total (dollars)	Dozen (dollars)	Skin (dollars)	Grade	No. (doz.)	Price Per Doz. (dollars)	Total (dollars)	Dozen (dollars)	Skin (dollars)
						GARMENT SUEDE					
F	6 (0.500)	47.00	23.50			G	1 (0.083)	43.00	3.57		
G	15 (1.250)	43.00	53.75			H*	16 (1.333)	25.00	33.33		
K	2 (0.167)	31.00	5.18			J†	7 (0.583)	15.00	8.75		
	23 (1.917)		82.43	43.00	3.58		24 (2.000)		45.65	22.83	1.90
							Difference			−20.17	−1.68
						SLIPPER UPPER					
X	7 (0.583)	41.00	23.90			X	1 (0.083)	41.00	3.40		
Y	15 (1.250)	38.00	47.50			Y*	3 (0.250)	38.00	9.50		
Z	1 (0.083)	34.00	2.82			Z†	20 (1.667)	34.00	56.68		
	23 (1.917)		74.22	38.72	3.23		24 (2.000)		69.58	34.79	2.90
							Difference			− 3.93	−0.33
						SHOE LINING					
Q	3 (0.250)	33.00	8.25			Q*	2 (0.167)	33.00	5.51		
R	4 (0.333)	31.00	10.32			R†	5 (0.417)	31.00	12.93		
	7 (0.583)		18.57	31.85	2.65		7 (0.583)		18.44	31.63	2.63
							Difference			− 0.22	−0.02

*Light to moderate cockle.
†Severe cockle.

Variations in Ked Populations

While it may seem of little consequence that ked populations followed different patterns on individual animals, the data from this test show some interesting trends. Figure 1 illustrates the three types of behavior observed, and the number of sheep on which each type was detected, as determined by five monthly ked counts. Numbers of keds transferred to the hosts, and their approximate dates of introduction, are also indicated on the graph. Type A behavior was charac-

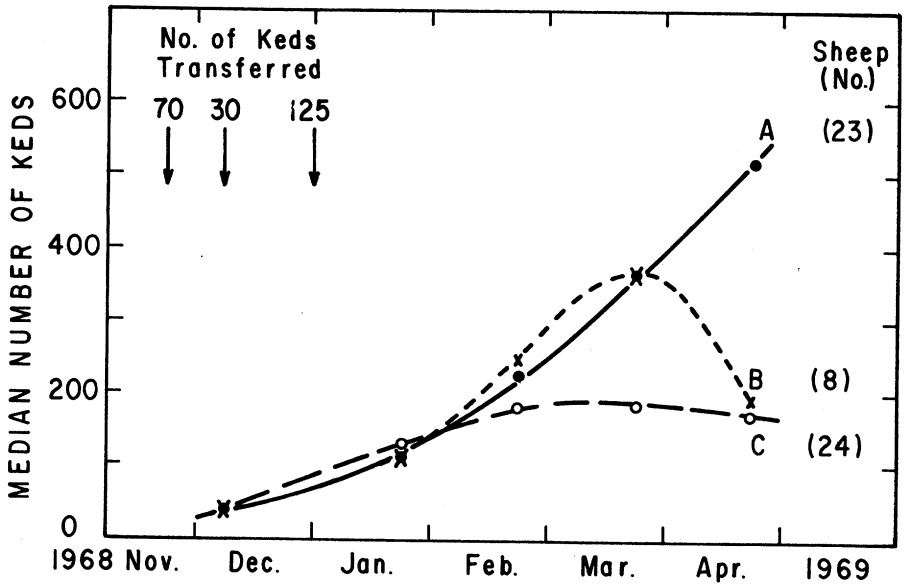

FIGURE 1.—Population curves showing three different types of ked behavior and the number of sheep with each type. Timing and level of experimental infestations are indicated by arrows.

terized by constantly increasing numbers, to an average peak of about 520, while in Type C there was essentially no change from the January count onward. Type B showed a rapid increase, to a peak of about 360 in March, followed by an abrupt drop to around 200. This apparently represents the development of host resistance, described by Nelson and Bainborough (21); the authors attribute this response to a constriction in the blood vessels of the skin, which reduces the amount of blood available to the keds, although there may be more than one form of this phenomenon (22).

Table VI shows the relative influence of the three types of ked behavior on weight gains, carcass data, and wool growth. It is apparent that the Type A behavior had a consistently detrimental effect on all of the measurements listed here, compared with the averages for the total group. Types B and C were less harmful, with values equal to or better than the group average. This is contrary

TABLE VI

INFLUENCE OF KED NUMBERS ON ANIMAL DATA

Characteristic	Average by Ked Behavior Type			
	Total 55 Sheep	A 23 Sheep	B 8 Sheep	C 24 Sheep
Final Ked Count	323	520	246	159
Live Weights (lbs.)				
Initial (Sept.)	40	39	40	41
Final (Apr.)	70	66	73	72
Gain	30	27	33	31
Carcass Data				
Dressed Wt. (lbs.)	26	24	27	27
Dress Percent	37	36	37	38
Standard Wool Staples				
Length (mm.)	26.8	26.0	27.5	27.3
Dry Wt. (g.)	0.774	0.683	0.769	0.865

to the findings of Nelson and Slen (18), who claimed that the adverse effects on weight gain and wool growth occurred only after the development of animal resistance (Type B).

On the other hand, the variations in ked populations showed little, if any, correlation with severity of cockle in the pickled skins or leathers. Table VII indicates that Type C was at least as injurious as Type A, while Type B may represent a milder effect, but fewer skins were available for this determination. Comparison of skin *vs.* leather grading shows perfect agreement in Type A, where most of the skins were made into slipper upper. There was poor agree-

TABLE VII

INFLUENCE OF KED NUMBERS ON COCKLE SEVERITY

	Number of Skins by Ked Behavior Type					
	A (23)		B (8)		C (24)	
	Skin	Leather	Skin	Leather	Skin	Leather
Cockle Severity						
Light-Moderate	8	8	4	5	6	10
Very Severe	15	15	4	3	18	14
Leather Lines						
Suede		8		4		12
Slipper		15		3		6
Lining		0		1		6

ment in Type C, which included more suedes and especially most of the linings. The latter tend to grade less severe in leather than in the pickle, and sorting of suedes is notoriously difficult with respect to true cockle (23).

SUMMARY

The estimated savings that might result from ked eradication, based on the results of this test, are summarized in Table VIII. From carcass and pickled skin values there is a difference of $2.08. If the skins are made into lining leather the total difference becomes $2.10, or if made into slipper leather it becomes $2.41. But if they go into garment suede the total difference becomes $3.76 per animal, and this is without any allowance for wool. From this potential benefit, a conservative estimate of 50 cents per head for cost of treatment can be deducted without seriously disturbing the prospects of a significant profit incentive. The table also indicates that the loss to the packer amounts to about nine percent, while the loss to the woolpuller is 29 percent. Downgrading of suede amounts to 47 percent of the control value, representing the major source of loss to tanners.

TABLE VIII

ESTIMATED SAVINGS FROM KED ERADICATION*

Sheep Product	Average Market Value Per Animal			
	Controls (dollars)	Infested (dollars)	Benefit (dollars)	Benefit (%)†
Dressed Carcasses	18.40	16.76	1.64	8.9
Pickled Skins	1.51	1.07	.44	29
			2.08	
Alternative Leathers:				
Shoe Lining	2.65	2.63	.02	0.8
Slipper Upper	3.23	2.90	.33	10
Garment Suede	3.58	1.90	1.68	47

*Estimated cost of treatment = $0.50
†Based on control.

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Director, Livestock Division Wool Laboratory, Consumer & Marketing Service, Denver, Colorado, provided the facilities and technical guidance for evaluating the wool staples; M. O. Brokke, Livestock Division, Meat Grading Branch, C. & M. S., Albuquerque, New Mexico, graded the carcasses; Dr. G. V. Richardson, Biometrical Services Division, A.R.S., Denver, Colorado, supplied statistical analyses of the data. The authors are especially appreciative of the faithful services of S. A. Apodaca, V.S.R., Albuquerque, New Mexico, without whose help the test could not have been completed.

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DISCUSSION

DR. DONOVAN (Canada Packers Limited): We have a written question from Mr. Jones of A. C. Lawrence, who participated in the test but who was not able to be here. He would like to know whether or not the Animal Health Division of the USDA will evaluate the information contained in the paper and, hopefully, take steps to initiate a compulsory treatment program.

MR. EVERETT: Yes, this is an unfortunate aspect of the outlook. We have an agency called Animal Health charged with the responsibility of eliminating the most harmful parasites from livestock, but their criterion for such action is based on whether or not they produce disease, and in this case, cockle is not classified as a disease, and therefore their hands are tied and they can't help us in any way to control it. So, from there we must progress down to the state level; each state must take action on its own, which, as anyone can guess, is a rather dim outlook, but still lends itself to some effect with the publicity campaign. This is the course we're on now, trying to work through our extension service to get to our livestock people to convince them of the need for this control.

We are aware that damage to leather will not open many ears; we have to go to the wool and meat interests and hope we will get enough information from a packaged approach such as this to find the incentive needed for state-by-state control, which, obviously, will take some time.

DR. DONOVAN: At the I.U.L.C.S. meeting in London last year, Dr. Vivian made the comment that in his experience there were several varieties of cockle. I would like to ask Mr. Everett to comment on this.

MR. EVERETT: There are indeed several varieties. Starting with Great Britain, a paper was given there in London from the BLMRA where they described rib cockle *versus* spread cockle. Rib cockle happens to be the same as our ked cockle; spread cockle is somewhat different. It has nodules that are randomly dispersed but don't seem to affect suede; it affects only the grain leather. They also recorded another condition — you might call it dermatitis or fungus infection, which tends to be confused sometimes with cockle in the tannery.

The situation in New Zealand is a little more complex because it's less understood. New Zealand skins have long been known for their good quality and relative absence of cockle. However, this has changed over the past few years; there has been an increasing incidence of cockle, much to the dismay of our New England tanners.

Speaking with Bill Vivian about this, I believe he has a rather uncertain opinion at the moment. He was able to confirm that they have keds in a certain small area of the islands, and that this indeed could cause the same kind of cockle we described. He maintains that over the bulk of the island they have another variety of cockle which is randomly dispersed, rather than linear, and he feels

this couldn't be caused by keds because they have a long-standing compulsory dipping program to control lice. This has been rumning for about 15 years, so he says, how can we have ked cockle if we dip our sheep? All the facts are not in, but there's still a possibility that dipping for lice is somewhat different from dipping for keds; in other words, flocks infested with lice are dipped, but those not having lice are not usually treated.

There's plenty of room for variable numbers of ked-infested flocks that might still explain the observations. As I say, the facts are not all in, and we're still not certain what the situation is with New Zealand skins.

DR. SELIGSBERGER: It is not quite clear to me, Mr. Everett, why lining leather should not show the same loss in value as garment leather or slipper leather. Maybe you can explain on what basis you arrive at this loss in value.

MR. EVERETT: It's based principally, of course, on the tanner's sorting. All these leathers are graded by the tanner, but he had told me before that cockle doesn't affect lining, mainly, I take it, because they're pressed out with more pressure, which tends to level the cockle. Also they often apply pigment finishes and so on that tend to hide the appearance on the grain and, of course, there's no involvement on the flesh side to worry about; it's purely the grain.

With good processing, the nodules on the grain can be leveled quite a bit, and the grain is greatly improved by good processing, which tends to minimize the effect in grain leathers.

DR. DONOVAN: May I ask Mr. Everett, then, how prevalent ked infestation is in North America and whether or not there is anything similar in cattle for which a common treatment might be developed?

MR. EVERETT: Cockle in sheep is enough; I'm sure it isn't present in cattle. Keds are widespread throughout North America and, for that matter, over many parts of the world. They are more prevalent in temperate climates where moderate-to-cool temperatures prevail, rather than in hot desert climates. The keds prefer lower temperature and higher humidity, and this can, of course, cover a large part of the world, so that the upper half of the United States at least has serious problems with keds. Canada also is known to have high numbers; South America is a little uncertain. Not much has been reported from there, but I'm sure they occur there. South Africa has plenty of it, and New Zealand in limited parts of the island. Great Britain and France, and western Europe in general, are bothered to a rather serious extent.

DR. DONOVAN: If there are no further questions, I'll thank Mr. Everett, on behalf of us all, for his excellent presentation.